## **GEOLOGY**

## CARLSBAD CAVERNS WEST QUADRANGLE, NEW MEXICO-TEXAS

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## INTRODUCTION

The Carlsbad Caverns West quad- mapped as a tongue of the San Andres shaped outcrop areas, most of which (1953), the reef facies occurring north- present along the Big Canyon drainrangle is located in the southwestern formation. The contact used in this are located on or near the northeast- east of and on top of the reef-talus age course near the New Mexicopart of Eddy County, N. Mex., and report is illustrated in columnar sec- erly-trending Guadalupe Ridge. The facies (see stratigraphic diagram). Texas State line. covers an area of about 252 square tion 1. miles. The total relief in the quadThe contact between the Grayburg and the overlying Tansill formation three different lithologic types in the to lie conformably on a thin siltstone rangle is about 3,250 feet with alti- formation and the overlying Queen are conformable with the Yates for- Capitan limestone. His "particularly interval at the top of the Bell Canyon tudes ranging from less than 3.750 formation is arbitrary. Both formamation. The Yates contrasts with the massive layers" correspond in general formation. The top of the Castile feet in Double Canyon Draw to more tions are composed of interbedded formations above and below, because to the reef facies of Newell and others, formation has been eroded wherever than 7,000 feet on Lonesome Ridge in dolomite and sandstone but sandstone it contains a number of slope-forming whereas the remainder of the Capital it occurs in the Carlsbad Caverns the Guadalupe Mountains. The part is relatively more abundant in the siltstone and sandstone beds alternat- tan as mapped by King corresponds West quadrangle and in most places of the quadrangle northwest of Gua- Queen. Between the mouth of Payne ing with dolomite ledges whereas the roughly with the reef-talus facies of it is overlain by deposits of Quaternary dalupe Ridge is drained by Dark
Canyon and the abandoned C.C.C.
Seven Rivers and Tansill formations
are almost devoid of clastic beds.

Newell and others.

The southeastern facies of the Capithe Capital Seven Rivers and Tansill formations are almost devoid of clastic beds.

locale of many geologic field conferences. Heretofore, however, no detailed geologic map of this quadrangle Grayburg into the lower part of the The gradation of Yates into Capitan A-A'). has been published. Geologic mapping Goat Seep limestone (Newellandothers is illustrated in columnar sections 7, The more massive northwestern

has been published. Geologic mapping was done in the field with the aid of vertical aerial photographs.

The authors are indebted to many of the personnel of the Carlsbad Caverns National Park and Lincoln National

Goat Seep limestone (Newellandothers is illustrated in columnar sections 7, 8, and 9 and in the stratigraphic diagram.

Sand 9 and in the stratigraphic diagram.

Lateral gradation in the Yates formation of carbonate beds into sulfate beds in a northerly direction, similar grades laterally into the Bell Canyon depths of several hundred feet. These deposits consist of detritus derived Forest and to the ranchers in the area diagram. ful advice and criticism.

## STRATIGRAPHY OF PERMIAN ROCKS

QUEEN FORMATION

Rivers formation is present at the

numerous nearby outliers, and in one

at the location of his section. The Carlsbad Caverns West quadrangle straddles the marginal reef area between the Delaware Basin to the southeast and the northwestern the southeast and the northwestern shelf area as it existed in the Guada-lupe epoch of the Permian. The gross relations between the rock units exercise the southeast and the northwestern are widely distributed throughout the mation occurs in a series of relatively small outliers near the southeast edge of the Capitan is not exposed in the best exposures of the entire formation occurs in a series of relatively small outliers near the southeast edge of the Capitan is not exposed in the Carlsbad Caverns West quadrangle, of the Guadalupe Mountains. The posed within the quadrangle are shown are in the upper end of Dark Canyon. Tansill formation is not overlain by but a vertical section of more than on the stratigraphic diagram, which also indicates the southeastward minamed (Crandall, 1929) "from extenCarlsbad Caverns West quadrangle, of Big Canyon. King (1948) reports

The Carlsbad Caverns West quadrangle, gration of the Delaware Basin margin

sive outcrops in the vicinity of Queen,"

but in the subsurface to the northeast

thicknesses of as much as 2,000 feet in

rangle is several miles east of the during that epoch. The columnar secduring that epoch. The columnar sections illustrate the change of lithology from the shelf area towards the Basin margin.

the quadrangle. Recently a type section was established in Dark Canyon just below the mouth of Payne Canyon upper part of the Capitan limestone

the southern Guadalupe formation of Permian age. The Tansill formation grades laterally into the upper most part of the Bell faults are present on the surface of the

SAN ANDRES FORMATION (Moran, 1954, 1954a). The upper and the transition between the Yates and eral small outcrops near the mouth of in the quadrangle is characterized by Exposures of the San Andres forma- lower boundaries of the Queen forma- Capitan formations. The Tansill-Cap- Big Canyon in the southwestern cor- a 1° to 2° northeasterly regional dip tion are confined to the northwest tion as defined by Moran are shown itan transition is similar to the Seven ner of the area and a small outcrop of which is interrupted by the southeastpart of the Carlsbad Caverns West on the geologic map. Approximately Rivers-Capitan transition and is illus-somewhat lower beds is present in the dipping Reef Escarpment and the quadrangle where more than 300 feet the uppermost 100 feet of the formatrated in the stratigraphic diagram. mouth of Black Canyon 3 miles to northeast-dipping Huapache monoof the formation is exposed in Last tion is predominantly siltstone and Within the Carlsbad Caverns West the northeast.

The basal contact of the San Andres tuck member of Newell is a convenient in the subsurface to the northeast, it you formation is not exposed in the ently are partly the result of Cenozoic formation is not exposed in the quad- subdivision, but is not shown sepa- is known to grade laterally into a sul- Carlsbad Caverns West quadrangle. folding along the trend of the older rangle. The contact with the overlying rately on the geologic map. fate facies a few miles north of the The contact with the overlying Castile Bone Spring fiexure (King, 1948), Grayburg formation is probably un- The upper contact of the Queen, transition between the Tansill and formation may be seen in sec. 34. which presumably defined the northconformable. The unconformity is ap- with the Seven Rivers formation, is the Capitan.

T. 26 S., R. 22 E. along the New west margin of the Delaware Basin parently restricted to a relatively conformable, fairly sharp, and con- Although the top is exposed to ero- Mexico-Texas State line in the south- during early Permian time. The Delasmall area or narrow band, however, sistent. It is easily recognized at the sion, the Tansill formation and its western part of the quadrangle. Here ware Basin, which has been described as the contact appears to be conform- top of the relatively nonresistant equivalent beds in the Capitan lime- the upper part of the Bell Canyon in many previous papers, was a Perable at most exposures in the quad- series of siltstone beds that make up stone are at least 300 feet thick near consists of dark-gray, fetid, thinly mian sedimentary basin about 100 rangles to the north and west. The the Shattuck member of Newell. The the mouth of Slaughter Canyon (corelatively thick bedded limestone at overlying Seven Rivers formation lumnar section 9), but thin rapidly limestone member - overlain by thin and about 150 miles across from north the top of the San Andres contrasts consists almost entirely of resistant northwestward. According to DeFord brownish-weathering siltstone. Brown- to south (King, 1948). A shallow markedly with the thinner bedded, dolomite. lighter colored dolomite and inter
It is known from exposures in the ranges between 100 and 150 feet in stone beds of the Castile formation rest to the Reef Escarpment on the northbedded sandstone of the Grayburg walls of North McKittrick Canyon, 3 thickness. miles west of the Carlsbad Caverns The upper part of the San Andres West quadrangle, that most of the formation grades southeastward into

Queen formation grades laterally into

The Capitan limestone is exposed

grades laterally into the Capitan lime
The syncline extends for a distance of the sandstone tongue of the Cherry the upper part of the Goat Seep lime- in a continuous outcrop belt along the stone of the Basin margin. Canyon formation. This transition, stone. The upper part of Newell's southeast edge of the Guadalupe Only a few tens of feet of Bell Canwhich is displayed in Last Chance Shattuck member may pinch out be- Mountains and forms the Reef Escarp- you is exposed in the Carlsbad Caverns quadrangle to the longitude of White Canyon in the quadrangle to the tween the Goat Seep and the overlying ment (King, 1948). Neither the base West quadrangle. At the type locality,

San Andres formation 20 to 70 feet but the transition is indicated in the in McKittrick Canyon just west of the sandstone. thick extends eastward between the stratigraphic diagram. sandstone tongue of the Cherry Can- The thickness of the Queen forma- the Capitan is known to rest with yon formation and the Grayburg tion at the type locality is 421 feet apparent conformity on the Goat Seep The Castile formation is exposed in the ancient structural zone are to be formation in Sitting Bull and Gilson (Moran, 1954, 1954a). Farther down limestone and its Basin equivalent, three small areas within the Carlsbad found in several oil test holes, most of is an intertonguing relationship com-tion 4). bined with intrabed transition from calcareous dolomite to sandy dolomite to dolomitic sandstone. Within indiOverlying the Queen formation is are shown on the geologic map. These corner of the quadrangle; and (3) may be related to this ancient strucvidual beds, this transition often takes the Carlsbad group, consisting of three facies were called the reef facies and thinly laminated limestone represent-tural trend. The Huapache monocline place in a horizontal distance of less formations all of which are laterally

than 50 feet. Boyd (1955) has ob- equivalent to the Capitan limestone served a similar relationship between of the Delaware Basin margin area. the San Andres and Cherry Canyon These formations are the Seven Rivformations in the Brokeoff Mountains ers, the Yates, and the Tansill. about 19 miles to the southwest. Seven Rivers formation.—The Seven SANDSTONE TONGUE OF THE surface in a broad outcrop band, in CHERRY CANYON FORMATION Sandstone, with an exposed thick- inlier in the northwest part of the ness of about 200 feet, is present in quadrangle. The Seven Rivers is con-Sitting Bull and Gilson Canyons in the formably overlain by the Yates for-

northwestern corner of the quadrangle. mation. The base of the Yates is On the basis of lithologic characteris- recognized by the appearance of the tics and stratigraphic relationships, lowest of a series of siltstone beds this sandstone is correlated with the (columnar sections 6, 7, and 8). sandstone tongue of the Cherry Can- The Seven Rivers formation grades yon formation of the southern part of laterally into the lower part of the the Guadalupe Mountains (New Mex- Capitan limestone of the Delaware ico Geological Society, 1954). Basin margin area. In stratigraphi-The base of the tongue of the Cherry cally higher beds this facies change Canyon formation is not exposed in takes place progressively to the souththis quadrangle but elsewhere it is east as is indicated in the stratigraphic underlain by the Cutoff shaly member diagram and in columnar sections 6, of the Bone Spring limestone (Boyd, 7, 8, and 9. Individual beds thicken 1955; King, 1948). Less than half a considerably and change from dolomile north of the Carlsbad Caverns mite to limestone within a horizontal West quadrangle, in Last Chance distance of several hundred feet. Canyon (sec. 33, T. 23 S., R. 22 E.), A few miles to the northwest of the there is some fetid dark-gray thin- gradation between the Capitan and bedded cherty limestone beneath the Seven Rivers formations, another lat-Cherry Canyon that may represent eral gradation from predominant dolomite to predominant gypsum occurs The sandstone tongue of the Cherry within the Seven Rivers. This takes Canyon formation is overlain by a place in and near Johnson Canyon, as

tongue of the San Andres formation shown by a dashed line on the geologic into which it grades both laterally map. Within the limits of the Carlsbad and vertically. Caverns West quadrangle the gypsiferous facies contains a rather high GRAYBURG FORMATION percentage of dolomite, but the per-The Grayburg formation crops out centage of dolomite decreases in a in Dark Canyon, Turkey Canyon, northwesterly direction. Bates (1942) Robinson Draw, and in two very small has described this lateral gradation patches in Putman and Kirkland Can- within the Seven Rivers as it appears yons. It also forms much of the surface in Rocky Arroyo about 14 miles north in the northwest part of the area. of this quadrangle. The Grayburg formation was orig
The Seven Rivers formation is about inally described as a subsurface unit 460 feet thick in Bear Canyon (column (Dickey, 1940), but Moran (1954, nar section 5) and probably maintains 1954a) proposed a type surface section similar thicknesses to the southwest of the formation in Sitting Bull and and northeast at equivalent distances Gilson Canyons in this quadrangle. from its gradation into the Capitan The top of the Grayburg as proposed limestone. However, it thickens to by Moran is unmodified in this report, more than 500 feet nearer the Capitan but we have chosen a basal contact limestone and apparently thins somethat is probably 40 to 50 feet above what within the evaporite facies. that used by Moran, who apparently Yates formation. - The Yates for-

to the dolomite-gypsum gradation of formation of the Delaware Basin. deposits consist of detritus derived who helped in various ways to expewho helped in various ways to expeMoran (1954, 1954a) measured 475
the Seven Rivers formation, takes
Probably the uppermost part of the dite the mapping during the late feet of the Grayburg formation in place in the subsurface to the northeast Capitan grades laterally into the basal minor extent from the sandstone and winter of 1955. Space does not permit

Sitting Bull and Gilson Canyons and but the rocks showing this gradation beds of the Castile formation (Newell siltstone of the Guadalupe Mounindividual enumeration of the many geologists who have contributed helpindividual enumeration of the many geologists who have contributed help
we measured a thickness of about 435 have been removed by erosion in the feet in Gilson and Trimble Canyons

Carlsbad Caverns West quadrangle.

tains. They have been deposited in the form of a broad alluvial apron (columnar sections 1, 2, and 3). In North Slaughter Canyon the Some limestone beds of the Bell Can-Moran's measurement apparently includes a tongue of the San Andres formation which is about 50 feet thick extension of the San Andres formation which is about 50 feet thick extension of the section 8). Closer to its formation which is about 50 feet thick extension of the Some limestone beds of the Bell Canyon of the mountains.

Valley-bottom alluvium of Quaternary age is present in most of the mountains. formation may reach a thickness of gradation has been described in detail larger drainage courses in the quadtion the thickness decreases slightly. others (1953) and is indicated in the fusion of patterns on the geologic map Exposures of the Queen formation Tansill formation.—The Tansill for-stratigraphic diagram.

CAPITAN LIMESTONE southwest corner of the quadrangle,

300 feet or more; in the opposite direc- by King (1948) and by Newell and rangle, but in order to avoid a con-

The Queen sand was originally any younger formation within the 1,500 feet can be seen near the mouth

CASTILE FORMATION

Canyons as shown in columnar sec- Dark Canyon, in the SE 1/4 sec. 29, the Cherry Canyon formation (see Caverns West quadrangle: (1) mas- which were drilled beyond the limits tion 1. The lateral transition from the T. 24 S., R. 23 E., the thickness was stratigraphic diagram). In the sub-San Andres into the Cherry Canyon measured as 370 feet (columnar sec- surface to the northeast the Capitan east edge of the quadrangle near rangle and are therefore not in the limestone is overlain by the Salado Rattlesnake Canyon; (2) interlamirealm of this report. The slight angular Two facies of the Capitan limestone seen near the extreme southeastern formation in Last Chance Canyon

underlying Seven Rivers formation King (1948) recognized and mapped The basal beds of the Castile appear

the ridge is drained by Black River. mapped at the base of a prominent The Yates grades laterally into the tan limestone is characterized in part grades upward into the Salado forma-Both of these drainage systems are sandstone bed that is thicker than any middle part of the Capitan limestone by indistinct thick beds that dip tion. The basal part of the Castile occurring in the Grayburg. However, to the southeast. The change occurs a southeastward from 20° to 30°. This probably grades laterally into the The Guadalupe Mountain area, of which the Carlsbad Caverns West because this basal sandstone of the Queen is variable in thickess and diffiquadrangle is a part, has been the cult to trace with certainty, it is and Capitan described above. While and others (1953). However, it is the remainder of the Castile grades subject of numerous published and possible that the contact is not mapped the clastic beds of the Yates thin and believed that probably at least 10° of laterally into the lower part of the unpublished geologic papers, and the at exactly the same horizon in all pinch out or grade laterally into limestone, the dolomite beds simultane- warping along the edge of the Dela- gin in the subsurface to the northeast.

alluvium is shown only in the valley

STRUCTURAL GEOLOGY now in ruins, on the western edge of the Tansill is overlain by the Salado the southern Guadalupe Mountains. north-northwest trending normal fault in the SW 1/4 sec. 36, T. 24 S., R. 22 E. a short distance to the southeast of Canyon formation is exposed in sev-

Chance, White Oaks, Sitting Bull, and Gilson Canyons.

was called the Shattuck member by Annual Control of the Bell Cansulation Consists almost entirely of dolomite, but as a sists almost entirely of dolomite, but as a sist and a sist and a sist almost entirely of dolomite, but as a sist and a sist an and Riggs (1941) the Tansill normally ish weathering thinly laminated limewith apparent conformity on this silt- west has been called the Walnut stone. As stated earlier, the Bell Can- Canyon syncline (Hayes, 1957) and is yon formation of the Delaware Basin younger than the Permian in origin. about 25 miles from near the west north, takes place beneath the surface Capitan limestone. Erosion in this nor the top of the formation can be a few miles to the south of this quadbetween White Oaks and Sitting Bull quadrangle has not progressed far seen within the Carlsbad Caverns West rangle, the formation is 670 feet thick The northeast-dipping Huapache Canyons. However, a tongue of the enough to expose these relationships, quadrangle. However, from exposures (King, 1948) and is predominantly monocline resulted from flexing after the Permian along a structural zone

apparently established no later than early in the Permian. Evidences for nated gypsum and limestone may be unconformity beneath the Grayburg

included part or all of what is here mation is exposed in many irregularly reef-talus facies by Newell and others ing the basal part of the Castile is extends for many miles northwest of Mississippian, Devonian, and Ordo-tions locally contain water which in Hayes, P. T., 1957, Geology of the Conf., illus., p. 147-150. the quadrangle and may extend for a vician ages, all of which produce oil places comes to the surface in springs Carlsbad Caverns East quadrangle, Moran, W. R., 1954a, Proposed type few miles into the Delaware Basin east of the Pecos River in southeastern and seeps. Synclinal areas underlain New Mexico: U. S. Geol. Survey sections for the Queen and Graysoutheast of the quadrangle (Hayes, New Mexico. by these rocks offer the best ground Quad. Map GQ 98. Southeast of the Reef Escarpment, water possibilities. ECONOMIC GEOLOGY rocks of Permian age as well as older The more heavily alluviated drain- and distribution of potassium min- County, N. Mex. (abs.): Geol. Soc. OIL AND GAS

and were abandoned. The Randel Lamar limestone member of the Bell MINERAL DEPOSITS and were abandoned. The Randel No. 1 Thurman well in the NW1/4 Sec. 9, T. 26 S., R. 24 E., was drilled in 1952 to a depth of 595 feet into sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountain group (consisting of the Brushy Canyon, Cherry Caninto sandstone of the upper part of the Delaware Mountains region, Texas and New Mexico: San Francisco, W. H.

No metalliferous deposits of any potential economic value are known within the Carlsbad Caverns West quadrangle, and only very major Bell Canyon formation. The John A.
Yates No. 1 Matlock well in the

NWING NEED TO THE Upper part of the part of the part of the conditions of Guadalupian age of the part of t Yates No. 1 Matlock well in the NW1/4 NE1/4 sec. 8 of the same townNW1/4 NE1/4 sec. 8 of the same townA well in sec. 29, T. 26 S., R. 27 E.,

A well in sec. 29, T. 26 S., R. 27 E., ship was drilled in 1956 to a depth of 3,500 feet into a sandstone of unreported age. The Union Oil Co. of California No. 1 White-Federal well in the NW1/4 NW1/4 sec. 17. T. 24 S.

in the NW¼ NW¼ sec. 17, T. 24 S.,
R. 22 E., drilled in 1955-1956 to a
total depth of 6,737 feet, was reported

the Carispad Caverns West quantum rangle west of this production, up-dip pinchouts of permeable rocks of Permian age, along the possible extension to have reached rocks of Devonian age. of the Huapache flexure, might form Within the Guadalupe Mountain stratigraphic traps in which oil may area of this quadrangle the best possibilities for oil and gas lie in the rocks production from rocks older than the older than the Permian. A thick section of marine rocks of Paleozoic age duction to the east, in sec. 21, T. 26 S., underlies the area, and with proper R. 27 E., of gas from a depth of structural conditions oil may have 12,500 feet in a well in which rocks of been trapped in one or more of several

Pennsylvanian age were reported to formations that range in age from have been penetrated at a depth of tigraphy of southeastern New Mex-Ordovician to Permian. Although pre- 10,800 feet. vious tests along the Huapache monocline to the north have been failures, GROUND WATER this ancient structural trend remains The gravel apron in the south- DeFord, R. K., and Riggs, G. D.

Crandall, K. H., 1929, Permian straogists Bull., v. 13, p. 927-944. the most favorable area for explora- eastern part of the quadrangle con- 1941, Tansill formation, West Texas tion. The Humble Oil and Refining tains substantial quantities of ground and southeastern New Mexico: Am. Co. No. 1 Huapache Unit well, located water and is probably the most reliable Assoc. Petroleum Geologists Bull., on the monocline less than a mile source in the area. In the Guadalupe v. 25, p. 1713-1728. north of this quadrangle in the W1/2 Mountains, however, the occurrence Dickey, R. I., 1940, Geologic sec-SW 1/4 NW 1/4 sec. 35, T. 23 S., R. 22 E., of ground water is much more difficult tion from Fisher County through

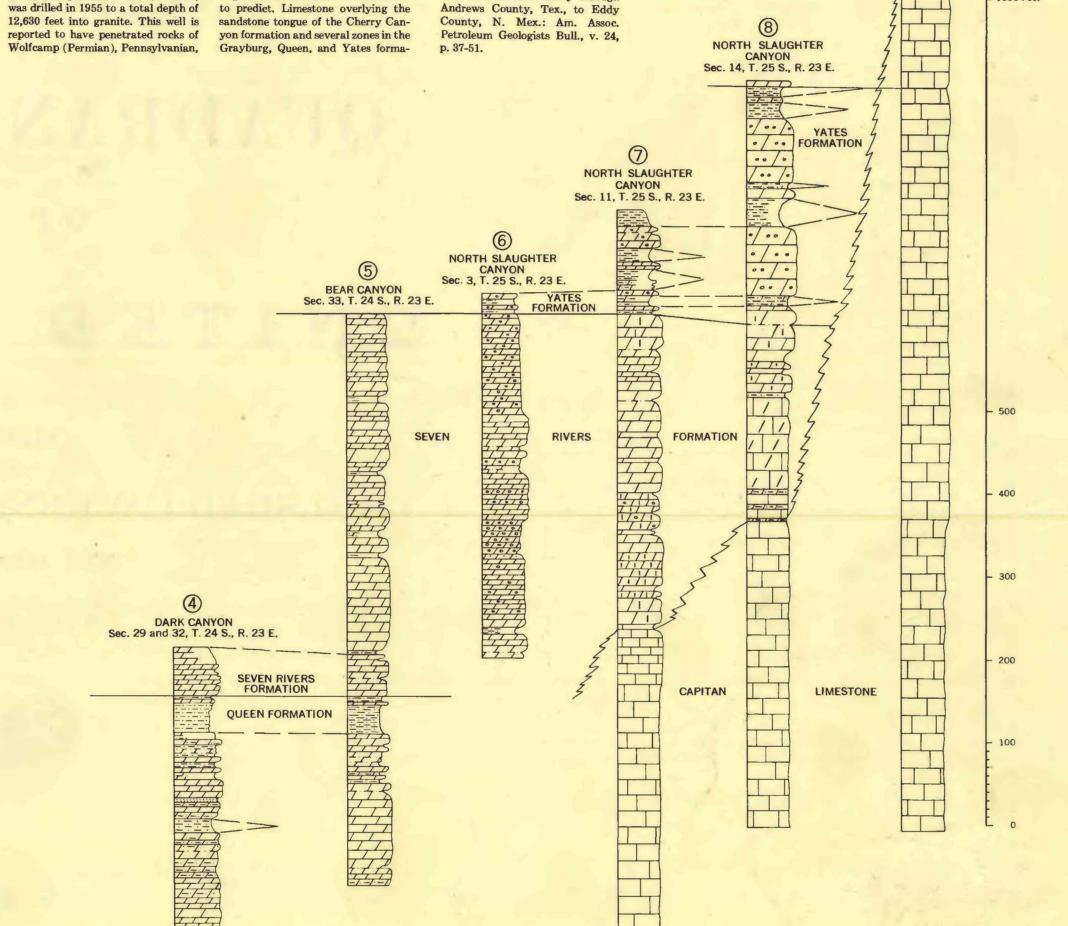
economic importance.

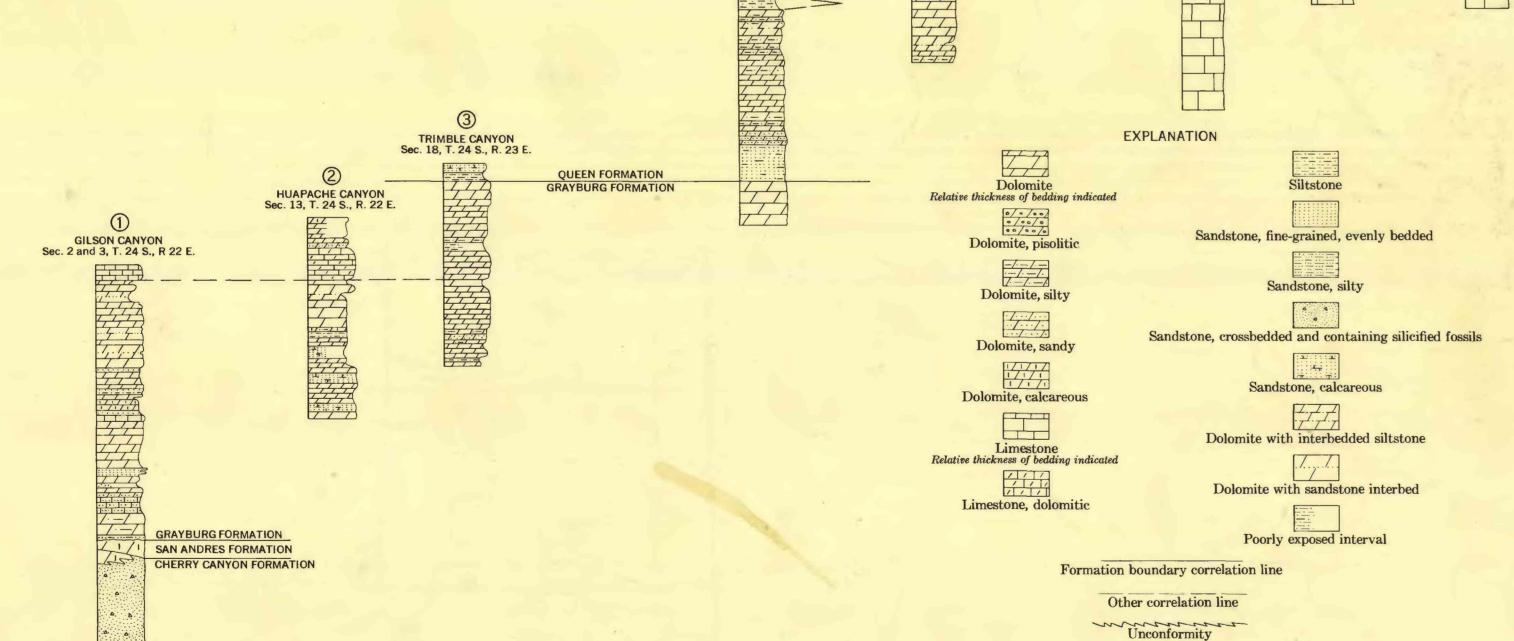
Bates, R. L., 1942, Lateral gradation

burg formations of Guadalupian age Jones, C. L., 1954, The occurrence in the Guadalupe Mountains, Eddy rocks contain potential oil-bearing age courses such as Dark Canyon and erals in southeastern New Mexico: America Bull., v. 65, p. 1288. The three exploratory wells drilled zones. About 13 miles east of the Last Chance Canyon contain a num
N. Mex. Geol. Soc. Guidebook, 5th

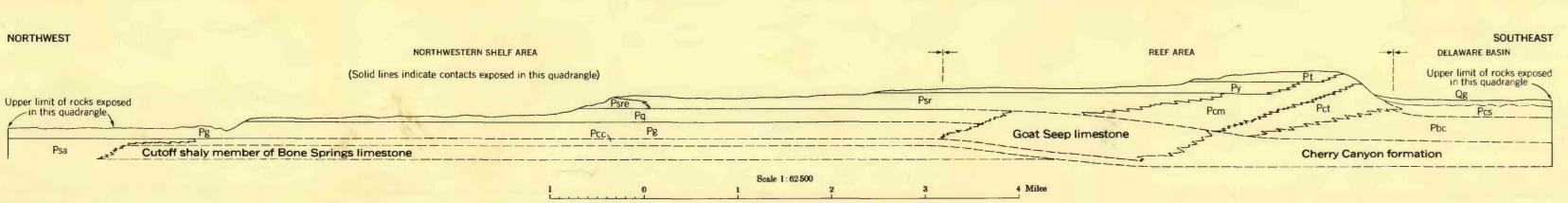
Newell, N. D., Rigby, J. K., Fischer, Caverns West quadrangle before January 1, 1957, were all unsuccessful Tex.: U. S. Geol. Survey Prof.

in the Seven Rivers formation. Rocky Arroyo, Eddy County, N. ogists Bull., v. 26, p. 80-99. Boyd, D. W., 1955, San Andres forsoutheastern New Mexico (abs.): Geol. Soc. America Bull., v. 66, ico and adjacent parts of western Texas: Am. Assoc. Petroleum Geol-





COLUMNAR SECTIONS OF PERMIAN ROCKS IN THE CARLSBAD CAVERNS WEST QUADRANGLE



GENERALIZED STRATIGRAPHIC DIAGRAM ACROSS GUADALUPE MOUNTAINS SHOWING RELATIONS OF FORMATIONS AND MEMBERS

